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ABSTRACT

This paper describes an experiment which investigated the development of recall skills in 120 Caucasian, middle class children in the second, fourth, and sixth grades. Within each age group, four experimental groups were formed in which subjects were asked to remember and recall 16 nouns by: (1) forming mental representations of each word (imagery), a unit transformation; (2) stringing the words together as in a short story (narrative), a complex unit transformation; (3) grouping the words into conceptual categories (clustering), an order transformation; or (4) saying the words aloud as they were presented, learn-only control instruction. The results obtained indicated that the unit-order model used might prove useful in studying the relative effectiveness of mnemonics and cognitive processing across age groups. Of particular interest are the findings that: (1) children who received mnemonic instructions showed superior recall to learn-only subjects; and (2) simple transformations (imagery) were more effective at all age levels than more complex coding strategies (clustering and narrative). These findings replicate exactly the relationship found previously among different mnemonics with adult subjects. (ED)

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DEVELOPMENT OF MNEMONIC ELABORATION IN CHILDREN*

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Research on the development of recall skills in children has typically demonstrated that recall increases with age (Laurence, 1967; Moely, Olsen, Halwes, & Flavell, 1969). Two questions then arise: How is the incoming information coded, and are some coding strategies used more effectively than others at different developmental levels? In general, developmental research concerning mnemonic processing has not considered how different age groups compare on the relative effectiveness with which they can employ a particular mnemonic. The present study attempted to explore these questions in terms of a transformation model proposed by Kulhavy and Heinen (1974).

Kulhavy and Heinen suggested that the relative effectiveness of different mnemonic devices can be predicted based on the type and complexity of transformations necessary for encoding incoming information. These authors delineated two types of encoding transformations: unit transformations, which involve direct elaboration of single words, and order transformations, which involve rearranging and grouping words into common conceptual categories. In the initial test of their model, Kulhavy and Heinen required 80 college *Ss* to learn a 20-item, four-category stimulus list with instructions either to (*a*) form mental representations of each word (image), a unit transformation, (*b*) string the words together as in a short story (narrative), a complex unit transformation, (*c*) group the words into conceptual categories (cluster), an order transformation, or (*d*) say the words aloud as they were presented, a learn-only control instruction. The results showed that *Ss* instructed to form images recalled significantly more words than the other groups and that cluster-instructed *Ss* demonstrated superior organization in recall. These findings, replicated in a follow-up study (Haynes, Kulhavy, Sherman, & Caterino, 1974), lent support to the conceptualization of mnemonic coding processes along the lines of the model.

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Since predictions follow an analysis of mechanisms which underlie different coding strategies, the model appears to be particularly useful in guiding research on the development of mnemonic elaboration in children. The model predicts that performance in free recall tasks reflects the degree of elaboration needed for encoding with particular mnemonics. Predictions can be made and tested across various age levels. With this approach, one would expect to obtain information concerning not only the development of coding strategies across age levels, but also the effectiveness with which various age groups can employ different strategies. That is, one would expect that complex coding strategies which depend upon broad semantic repertoires, such as clustering, can be used by increasingly sophisticated learners, while relatively young *Ss* are capable of taking advantage of simple unit transformations, such as imagery (Paivio, 1971).

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In the present experiment, the above suggestions were explored using the four instruction conditions of the original test of the model, with groups at three developmental age levels: second, fourth, and sixth grades. It was predicted that the same functional differences between mnemonic strategies would be found with these younger subjects as had been found with adults. Specifically, children should show large differences in recall with instructions to use simple transformations when compared to recall with instructions to use complex unit or order transformations.

Method

Subjects

Subjects were 120 Caucasian children from a predominantly middle-class school district in Phoenix, Arizona. Three grade levels were used, second, fourth, and sixth, with 40 children from each grade. Average ages of *S*s were 7.4 years at the second grade, 9.5 years at the fourth grade, and 11.5 at the sixth grade. All *S*s were naive with respect to verbal learning experiments. *S*s who did not meet the minimum criterion of reading 13 of the 16 words presented in the experiment were replaced with *S*s taken randomly from the same population.

Design

Two conditions, pre-experimental instructions (I), and grade level (G) were combined factorially to form 12 treatment groups. Trials were used as within-*S* variable across each factorial cell. The design was, therefore, a 4 I (Imagery x Cluster x Narrative x Learn) by 3 G (2nd x 4th x 6th) by 2 T (Trials) mixed analysis of variance with repeated measures on T.

Materials and Procedure

The stimulus items were 16 nouns selected from the Battig and Montague (1969) category norms, representing the four categories, animals, transportation, clothing, and parts of the body. Selection of nouns was designed to meet the typical district. Items were randomly assigned to list position with the same sequence being used in all treatment groups. The words were typed, one word per card, using a primary typewriter on 3 x 5 filing cards.

As each *S* entered the experimental room, he was randomly assigned to one of four instruction groups within his grade level. He was then seated across from *E* who read instructions appropriate for his treatment. Imagery *S*s were instructed to form mental pictures of each word; cluster *S*s were asked to group the words together into categories; narrative *S*s were asked to use the words to make up a story which was meaningful to them; and learn-only *S*s were asked to say each word aloud during presentation.

Following practice with four sample items, the 16 words were individually shown to *S* at a 3-second presentation rate, with speed of exposure controlled by beeps from a tape recorder. *S* was required to read each word aloud, and then follow his individual instructions concerning learning procedures. If *S* could not read the word, it was supplied orally by *E*. To eliminate recall from STM, a

manipulation often ignored in past studies, *S* was required to perform an interpolated task at the end of the word list consisting of counting backwards by twos from a given number for a total of 30 seconds. Then, *S* was asked to recite the words remembered from the filing cards. This procedure was replicated for each of two trials. Following completion of trial 2, *S* was given a questionnaire assessing the degree to which he had used the appropriate learning strategy, and the degree to which he was able to categorize the nouns while looking at the complete list.

Results

Recall protocols were scored for both total recall and degree of organization for each trial. Repetitions and list intrusions were eliminated from all measures. Organization was calculated using the adjusted ratio of clustering, ARC, developed by Roenker, Thompson, and Brown (1971).

A 4 I x 3 G x 2 T analysis of variance on total recall scores yielded significance for Instruction (F (3, 208) = 5.43, $p < .005$), Grade level (F (2, 208) = 26.60, $p < .001$), and Trials (F (1, 108) = 223.37, $p < .001$), and the G x T (F (2, 108) = 18.83, $p < .001$), and the I x G x T (F (6, 108) = 3.79, $p < .005$) interactions.

Comparisons among the I means using Scheffé contrasts indicated that Imagery *S*s (Mean: 7.77) recalled significantly more words than the cluster (M: 7.23), narrative (M: 7.27), and learn-only (M: 6.35) groups ($p < .05$). While the cluster and narrative groups did not differ from each other, these groups recalled significantly more words than the learn-only group ($p < .05$). Further contrast comparisons revealed that the recall scores of the second grade *S*s (M: 5.86) were significantly lower than those of the fourth (M: 7.65) and sixth (M: 7.95) grade *S*s ($p < .01$), with no significant difference between these last two groups. The G x T interaction indicated that while the second graders improved slightly from trial 1 to trial 2, fourth and sixth graders showed even greater improvement across trials.

A 4 I x 3 G x 2 T analysis of variance of ARC scores, the clustering measure, did not yield significant main or interaction effects for any of the terms of the analysis. In addition, rank order correlations were calculated to determine if the order of recall reflected the order of presentation of the words. A three-way analysis of variance was then performed on the rho scores to check for any systematic order effect across conditions. The only significant effect was the I x G interaction (F (6, 208) = 4.67, $p < .001$). However, closer examination revealed that the rhos for all conditions were very low, ranging from -.20 to .24, and varied unsystematically across grade levels and instruction modes.

Discussion

The results obtained in the present study indicate that the unit-order model might, indeed, prove useful in studying the effectiveness with which various developmental age groups employ coding strategies. Of particular interest are the findings that (*a*) children who received mnemonic instructions showed superior

recall to the learn-only *S*s, and (2) simple transformations (imagery) were more effective at all age levels than more complex coding strategies (clustering and narrative). These findings replicate exactly the relationship found previously among different mnemonics with adult *S*s (Kulhavy & Heinen, 1974; Haynes, Kulhavy, Sherman, & Caterino, 1974).

The significant three-way interaction revealed that *S*s given instructions to image recalled more words on the first trial than other-instructed *S*s. The effect of practice with imagery instructions, as reflected in trial 2 scores, revealed a developmental trend with fourth and sixth graders showing a marked improvement while second graders recalled only slightly more words. In contrast, the learn-only *S*s not only recalled fewer words on the first trial than the mnemonic groups, but showed less improvement on trial 2 than any other instruction group at all grade levels. These differences support the interpretation that the imagery mnemonic, while used effectively at all age levels studied, becomes more effective with increasing age.

The cluster and narrative instruction conditions revealed some complex relationships. While *S*s instructed to cluster recalled more words than learn-only *S*s, the measure of clustering, ARC, did not reveal a significant difference in degree of clustering between the cluster condition and other conditions. Again, a developmental trend was suggested with second graders benefiting only slightly from practice with the clustering strategy, while fourth and sixth graders improved recall substantially across trials. First trial performance of narrative *S*s was more variable across grade levels than that of image-instructed *S*s, with the recall of second graders particularly impaired when compared to image-instructed second graders. With the difficult instructions to form a narration out of the words presented, fourth graders paralleled the low rate of improvement across trials of second graders while sixth graders were able to show a marked increase in recall by trial 2. Interpreting these findings along the lines of the model suggests that complex coding strategies become increasingly effective as *S*s acquire the sophisticated verbal repertoire upon which these strategies depend.

While *S*s with mnemonic instructions recalled more words than learn-only *S*s, indicating that instructions to transform does influence performance, it cannot be assumed that these differences are the direct consequence of the particular mnemonics used. For example, post-experimental assessment revealed that only 32 percent of the second graders were able to categorize the nouns while looking at the complete list. Although fourth and sixth graders could categorize the words, their post-experimental reports suggested that they simply "tried to remember the words." One plausible solution to this problem would be to give *S*s practice with the mnemonics until they reached some criterion. This approach would allow comparisons of *S*s at various developmental ages on the amount of training required to reach criterion. Furthermore, once *S*s learned to employ particular strategies, their performance with various mnemonics could be compared at various age levels.

In conclusion, the unit-order model can be used to guide investigations of the relative effectiveness of mnemonics and of cognitive processing across age groups.